C-Band / 5G Coexistence

FCC Debrief

Presented by Intelsat & SES

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Agenda

- C-band Operation Today
- C-band Operation with 5G
- C-band / 5G Coexistence Technical Study
- Conclusion

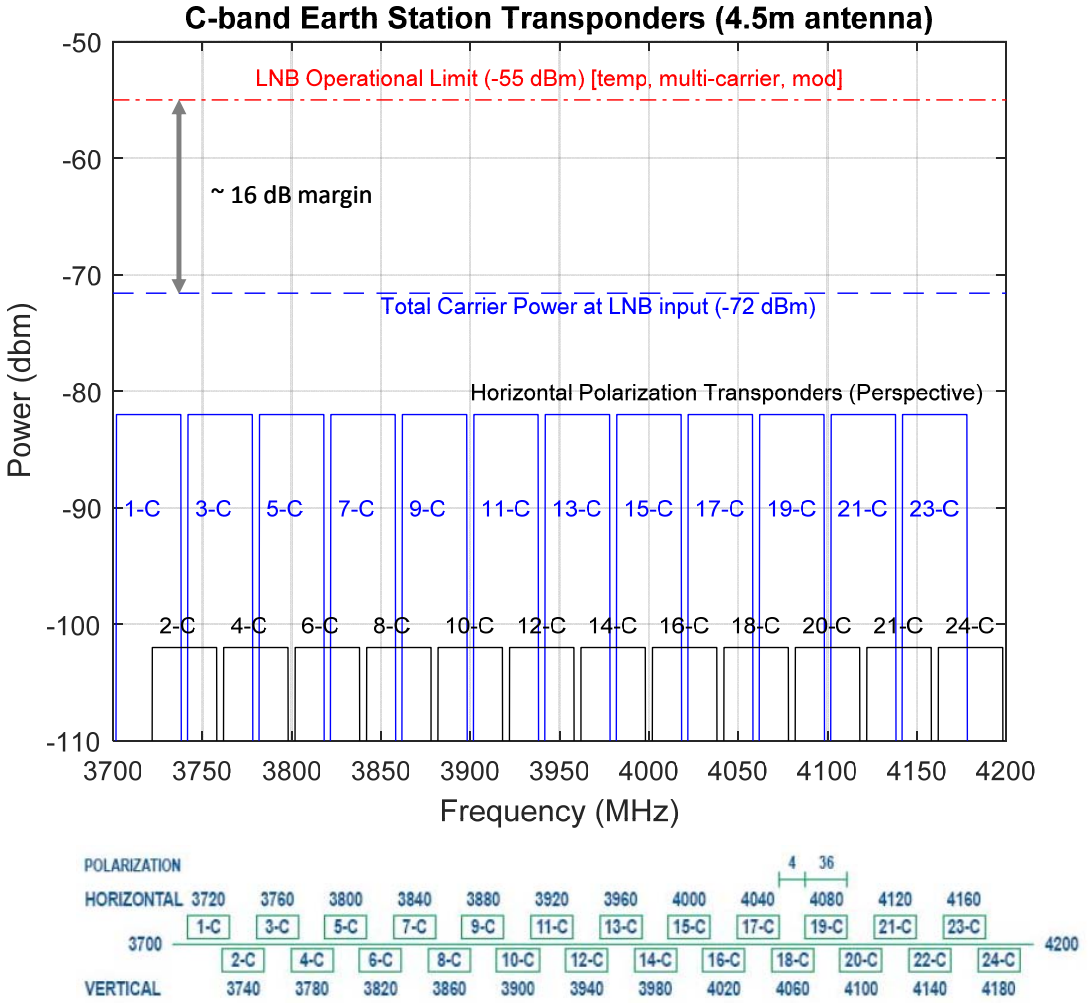
C-band Operation today
Illustrative Examples of Current C-band Link Performance

- C-band link budget for three representative Earth Stations (ES) in NY, LA, and Denver using Galaxy 14 at 125W
- The elevation angle in NY, LA and Denver are 20, 40, and 50 degrees, respectively
- The receive antenna dish sizes in NY, LA and Denver are 3.8m, 4.5m, and 3.7m, respectively
- The carrier power ranges from -115 to -112 dBW (-85 dBm to -82 dBm)
- The total C/(N+I) ranges from 16 dB to 19 dB

			New York	Los Angeles	Denver
	Parameter	Unit	E040273	E120164	E010074
Earth Station/GEO Satellite	Satellite Name		Galaxy 14	Galaxy 14	Galaxy 14
	GEO latitude	deg	0	0	0
	GEO longitude	deg	-125	-125	-125
	Earth Station latitude	deg	40.86027778	33.97644444	39.57972200
	Earth Station longitude	deg	-73.8837500	-118.3878056	-104.8597220
	elevation angle	deg	20.2	49.9	39.7
	azimuth angle	deg	242.2	191.7	209.9
	slant range	km	39536.5	37086.8	37806.0
	height Earth Station (AGL)	m	20	15	3.93
	system noise temperature	K	75	75	75
	transponder noise bandwidth	MHz	30	30	30
	transponder total bandwidth	MHz	36	36	36
	transponder center frequency	MHz	3860	3860	3860
	dowlink effective EIRP	dBw	39.6	40.8	41.5
	carrier wavelength	m	0.078	0.078	0.078
	pathloss	dB	196.1	195.6	195.7
	additional atmospheric loss	dB	0.1	0.1	0.1
	ES receive antenna size	m	3.8	4.5	3.7
	ES antenna mispointing loss	dB	0.5	0.5	0.5
	ES peak receive antenna gain	dBi	41.2	42.7	41.0
	carrier power	dBw	-115.4	-112.2	-113.3
	noise power	dBw	-135.1	-135.1	-135.1
	C/N (thermal)	dB	19.7	22.9	21.7
	Aggregrate Sat Interference	dBw	-138.5	-137.2	-137.8
	Margin (ASI, others)	dB	1.3	1.3	1.3
	C/N+I (total)	dB	16.3	19.0	18.1

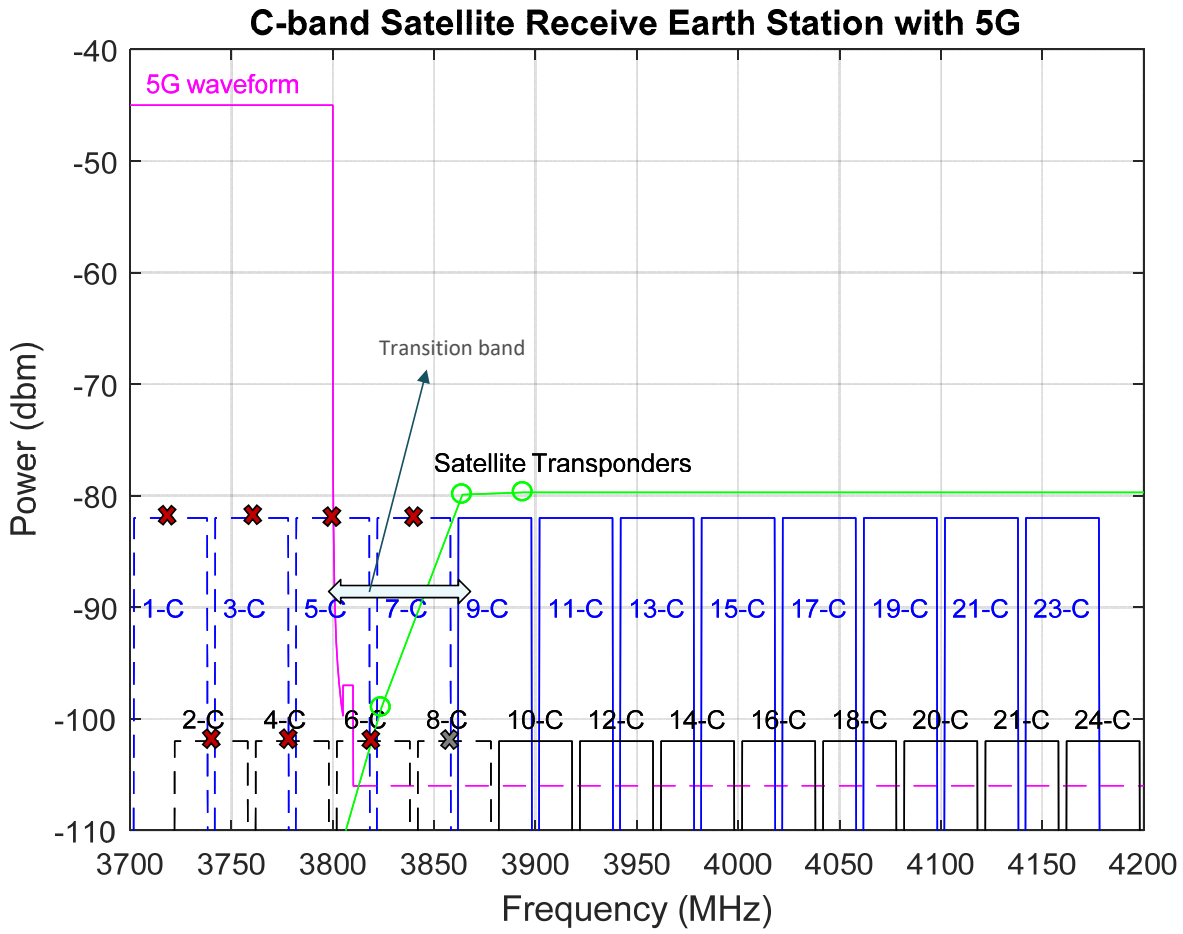
C-band Operation: Low Noise Block (LNB)

- C-band spectrum (3.7 - 4.2 GHz) carries 24 x 36 MHz transponders
- The LNB bandwidth is 500 MHz or larger – offers little or no OOB rejection
- The LNB operational limit is about -55 dBm (1 dB compression point)
- The total carrier power at LNB input is about -72 dBm (4.5m dish)
- Today we have approximately 16 dB margin before LNB operational limit is exceeded
- **Need to prevent 5G transmission from saturating the LNB**



C-band Operation with 5G Transmission

- Figure shows the layout of the satellite ES transponders and the 5G waveform
- The frequency separation between 5G and closest operational transponder (8-C or 9-C) is used as transition band
- The green curve shows employing filtering as a mitigation technique
- **Without mitigation, 5G signal can potentially cause the LNB to saturate**
  - Working with manufacturers to define filter with desired rejection/roll-off/insertion loss
  - Goal is adequate filter to avoid limiting 5G in band power
- **Right OOB emission mask needed to preserve C/N+I and avoid need for any site coordination or geographic limitations on 5G**



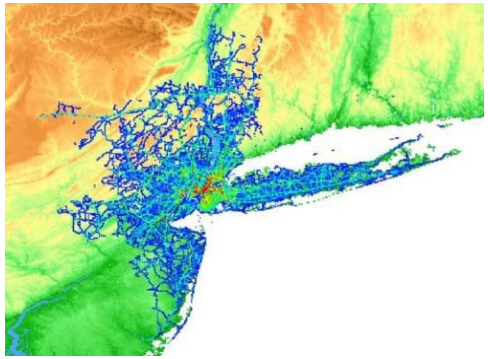
Compatibility Between FSS downlink and 5G

- Numerous studies showed that co-frequency sharing between 5G and FSS is not feasible
- Our C-band proposal does not involve co-frequency sharing with 5G
- However, 5G signals are considerably more powerful than satellite signals so we are engaged with 5G manufacturers to optimize adjacent band compatibility requirements
- Intelsat and SES are conducting a detailed and comprehensive empirical study to assess the impact of 5G

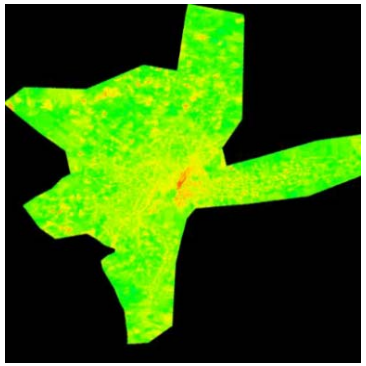
- **GENERAL ASSUMPTIONS USED IN OUR STUDY:**
- Three cities were selected for the assessment phase: NYC, Denver, and LA
- Actual cell tower location information (recognize actual 5G may be different)
- Current LTE deployment models
- 3GPP standards
- Typical earth station parameters – 3.7m and 4.5m antennas, COTS LNBs

C-band / 5G Coexistence Technical Study

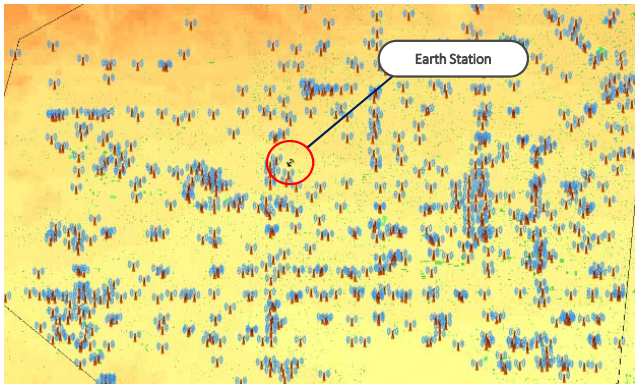
Actual Usage Data for 4G/LTE for all mobile operators in NYC



Power per m^2 projection for NYC Based on Actual Usage Data



Actual Earth Station and Actual base stations used for 4G/LT in LA



- C-band / 5G Coexistence study is being conducted to assess the impact of 5G base stations operating in the 3.7-3.8 GHz band on existing C-band earth stations
- Heat maps are generated to predict locations of 5G deployment that take actual 4G/LTE usage data as a reference
- Path loss model takes into consideration terrain and clutter data
- Mitigation techniques (filtering, shielding, LNB) are under evaluation

Summary

- A detailed C-band / 5G Coexistence Technical Study is being conducted to assess the performance of C-band Earth Stations
- Two primary impairments can affect the coexistence of the current C-band Earth Stations and the 5G transmissions

1) LNB saturation:

- 5G in-band transmissions will be received by the Earth stations and may drive the LNB into saturation
- Earth stations must be fitted with band-pass filters to prevent 5G signals from over-driving LNBs
- On-going consultation with filter manufacturers to design a filter that achieves desired attenuation in the smallest bandwidth possible – early analyses indicate that 40-60 MHz will be needed for the filter to achieve desired attenuation at 3.8 GHz

2) 5G OOB emission:

- 5G out-of-band transmissions will be received in band by the Earth station. Filtering doesn't help.
- Trade-off assessment of the BS transmission OOB is ongoing to determine the required OOBE requirements to meet the C/N+I performance
- Working closely with the mobile equipment manufacturers to further understand the actual transmission characteristics and any possible improvements